REMARKS

This paper responds to the Office Action dated on May 8, 2007.

Claims 1, 9, 14, 22, 30, 51 and 55 are amended, no claims are canceled, and no claims are added; as a result, claims 1, 2, 6-10, 14, 15, 19-23, 27-31, 35-37, 51, 52, 54-56 and 62 are now pending in this application.

§103 Rejection of the Claims

Claims 1, 2, 6, 7, 14, 15, 19, 20, 51, 52, 56 and 62 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma et al. (U.S. Patent No. 6,207,589) in view of Park (U.S. Patent No. 5,795,808) and Yano et al. (U.S. Patent No. 5,810,923). Applicant respectfully traverses this rejection.

The cited reference of Ma discloses deposition of a metal oxide gate dielectric of Zr or Hf alloyed with approximately 25% of a trivalent metal such as aluminum or lanthanum, formed by sputtering in an oxygen ambient. Ma teaches that it "would be advantageous if improved high-k dielectric materials could be formed by simply doping ... additional elements" (col. 2, lines 58-62) to existing high-k elements. Applicant respectfully submits that one of ordinary skill in the art would easily understand that Ma is teaching doping a high-k dielectric with another material to prevent "the formation of an interfacial SiO_2 layer" (col. 1 lines 45-47) by the addition of a "trivalent metal" (col. 2, lines 1-3) not to exceed 50% (col. 2, lines 1-3) of the total metal in the dielectric layer. Clearly, one of ordinary skill in the art would not understand Ma to be teaching the use of pure metal oxides, when Ma allows doping with a trivalent metal up to half of the oxide composition. The present application discusses the utility of using pure metal with a purity of 0.999999 at least at page 7 line 8. The present application teaches the utility of thermal evaporation of metal as opposed to sputtering at least at page 4, lines 10-21, while Ma teaches the use of reactive sputtering, which is shown in the present application at least in figures 2 and 3 and discussed on page 3 to cause surface irregularity and lack of smoothness.

Ma discloses an interface barrier 62 of 2-5 Å of silicon nitride or silicon oxynitride (col. 2, lines 11-17; col. 6, lines 4-11 and figures 12 and 13). Ma discloses the existence of "an interfacial SiO_2 layer" (col. 1 lines 45-47) and suggested the use of the interface barrier 62 to prevent increase in the interfacial layer. One of ordinary skill in the art could not possibly understand Ma to be teaching the direct contact of the high-k dielectric to the semiconductor material of the channel region. Ma teaches reactive sputtering in an oxygen ambient which will clearly cause the interfacial oxide layer, that the use of layer 62 is taught to minimize.

The cited reference of Park is used to show that sputtering and evaporation are art recognized equivalents (see outstanding Office Action on page 3, fourth paragraph). Applicant strongly objects to this characterization, and submits that the present application illustrates why this is incorrect, and why the use of sputtering may cause the rough surface and crystal damage shown in figure 2b and discussed at least on page 3, lines 17-23 and page 7, line 22. The result of this damage is discussed on page 3, line 1 as increasing the leakage current through the gate oxide by a factor of ten times for each 0.1 nm increase in roughness. Applicant respectfully submits that there could be no possible motivation in combining the Ma reference that teaches sputtering and not electron beam evaporation, or even that there may be a surface damage and roughness problem with sputtering, with the Park reference which states that sputtering and evaporation are equivalent and also provides no suggestion of surface damage and roughness problems. Applicant respectfully requests the Examiner indicate the portion of the cited references that would provide the suggestion to combine. The present specification (page 6, lines 9-18, and page 7, line 20) contrasts the use of a thermal evaporation technique for smooth surfaces and minimal unwanted silicides and oxides to improve the surface smoothness, while the cited references fail to mention anything with regard to these issues.

The cited reference of Yano is used to show that the deposition of a pure metal, the oxidation of metal, and that smooth metal oxide surfaces are known. Applicant respectfully submits that the cited reference teaches the deposition of an oxide film from an alloy of metals having up to 75% of a rare earth metal (col. 8, line 33) in a vacuum chamber with an oxidizing gas (col. 8, line 57) to form an epitaxial oxide layer. Applicant respectfully disagrees with the statement on page 4 of the outstanding Office Action that Yano teaches that it is known to make the metal amorphous, since Yano teaches not only crystalline dielectrics, but uses the term

epitaxial repeatedly throughout the entire specification, which one of ordinary skill in the art would easily understand to mean not just crystalline, but single crystalline material with a specific orientation. Applicant respectfully submits that the cited Yano reference teaches against the use of amorphous materials. Applicant respectfully submits that no one of ordinary skill in the art could possibly understand Yano to disclose the use of either pure metals, the direct contact of the dielectric to the semiconductor material, or an amorphous films.

Specifically, Applicant respectfully submits that the suggested combination of Ma with Park and Yano fails to describe or suggest at least the claimed feature of a "*...evaporation depositing a substantially amorphous and 0.99999 pure single element metal layer directly contacting a single crystal semiconductor portion of the body region using electron beam evaporation at a temperature between 150 to 200 °C...*", as recited in independent claim 1, as amended herein, with similar wording in the other independent claims. The cited references do not suggest the use of pure metal deposition, of the use of thermal evaporation as compared to sputtering, or directly contacting the semiconductor body region with the dielectric layer. Independent claims 14 and 51 are held to be patentable over the suggested combination of references for similar reasons.

The dependent claims are held to be patentable at least as depending from patentable base claims as shown above, since any claim depending from a nonobvious independent claim is also nonobvious. See M.P.E.P. § 2143.03. In view of the failure of the suggested combination of references to describe or suggest either thermal evaporation of pure metal, oxidation of the metal to form an amorphous oxide, or direct contact between the oxide and the substrate, Applicant requests this rejection under 35 U.S.C. § 103(a) be reconsidered and withdrawn.

Claims 8-10, 21 and 54 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma et al. (U.S. Patent No. 6,207,589) in view of Park (U.S. Patent No. 5,795,808) and Yano et al. (U.S. Patent No. 5,810,923) as applied to claims 1, 2, 6, 7, 14, 15, 18-20, 51, 52, 55, 56 and 62 above, and further in view of Moise et al. (U.S. Patent No. 6,211,035). Applicant respectfully traverses this rejection.

The cited references of Ma, Yano and Park have features discussed above with reference to the previous rejection. The cited reference of Moise is used to show that annealing in an inert ambient such as krypton, and in conjunction with the oxidizing anneal of Ma are known.

Applicant submits that the addition of the features of the Moise reference does not cure the above-noted deficiencies in the combination of Ma, Park and Yano. The combination does not suggest direct metal oxide contact to the body region, the use of pure metal, or the substantial amorphousness of the metal, none of which features are addressed in the cited Moise reference.

Applicant respectfully submits that the suggested combination of references fails to describe or suggest at least the claimed feature of a "*...evaporation depositing a substantially amorphous and 0.99999 pure single element metal layer directly contacting a single crystal semiconductor portion of the body region using electron beam evaporation at a temperature between 150 to 200 °C...*", as recited in independent claim 1, as amended herein, with similar wording in independent claims 9 and 51, from which the claims in question depend. The reasons are similar to those given above and previously.

The dependent claims are held to be patentable at least as depending from patentable base claims as shown above, since any claim depending from a nonobvious independent claim is also nonobvious. See M.P.E.P. § 2143.03. In view of the failure of the suggested combination of references to describe or suggest either thermal evaporation of pure metal, oxidation of the metal to form an amorphous oxide, or direct contact between the oxide and the semiconductor substrate, Applicant requests this rejection under 35 U.S.C. § 103(a) be withdrawn.

Claims 22, 23, 25, 27, 28, 30, 31, 33, 35 and 36 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma et al. (U.S. Patent No. 6,207,589) in view of Park (U.S. Patent No. 5,795,808) and Yano et al. (U.S. Patent No. 5,810,923) as applied to claims 1, 2, 6, 7, 14, 15, 18-20, 51, 52, 55, 56 and 62 above, and further in view of Maiti et al. (U.S. Patent No. 6,020,024) and in view of the admitted prior art (pages 1-4). Applicant respectfully traverses this rejection.

The cited references of Ma, Yano and Park have features discussed above with reference to the previous rejection. The cited reference of Maiti is used to show that transistors formed of a metal oxide with a high-k gate dielectric are known in the art.

Applicant submits that the addition of the Maiti reference does not cure the above-noted deficiencies in the combination of Ma, Park and Yano. The combination still does not suggest direct metal oxide contact to the body region, the use of pure metal, or the amorphous metal. Applicant respectfully disagrees with the statement on page 12 of the outstanding Office Action that sputtering and evaporation are art recognized equivalent processes, and again directs the Examiners attention to the present disclosure at least at page 3, lines 17-23 and page 7, line 22 on how sputtering may cause rough surfaces and crystal damage shown in figure 2b. The increased dielectric leakage current result of this damage is discussed on page 3, line 1. The present application at least on page 6, lines 9-18, and on page 7, line 20 shows how the use of thermal evaporation results in smooth surfaces, and in minimal unwanted silicides and oxides to improve the surface smoothness, as compared to sputtering. Applicant respectfully submits that any reference suggesting the use of sputtering is either teaching against the present application, or at a minimum is not cognizant of the issue that the present claimed invention addresses.

Specifically, Applicant respectfully submits that the suggested combination of references fails to describe or suggest at least the claimed feature of a "*...evaporation depositing a substantially amorphous and 0.99999 pure single element metal layer directly contacting the body region...;oxidizing the metal layer to form a metal oxide layer directly contacting the body region, wherein the metal oxide layer is amorphous and has a smooth surface...*", as recited in independent claim 22, as amended herein. The reasons are similar to those given above and previously.

The dependent claims are held to be patentable at least as depending from patentable base claims as shown above, since any claim depending from a nonobvious independent claim is also nonobvious. See M.P.E.P. § 2143.03. In view of the failure of the suggested combination of references to describe or suggest either thermal evaporation of pure metal, oxidation of the metal to form an amorphous oxide, or direct contact between the oxide and the semiconductor substrate, Applicant requests this rejection under 35 U.S.C. § 103(a) be withdrawn.

Claims 29 and 37 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma et al. (U.S. Patent No. 6,207,589), Park (U.S. Patent No. 5,795,808), Yano et al. (U.S. Patent No. 5,810,923), and Maiti et al. (U.S. Patent No. 6,020,024) as applied to claims 22, 23, 27, 28, 30,

31, 35 and 36 above, and further in view of Moise et al. (U.S. Patent No. 6,211,035). Applicant respectfully traverses this rejection.

The cited references have all been discussed above, and do not describe or suggest at least the claimed feature of "*...evaporation depositing a substantially amorphous and 0.99999 pure single element metal layer directly contacting the body region using electron beam evaporation... the metal being chosen from the group IVB elements of the periodic table; oxidizing the metal layer to form a metal oxide layer directly contacting the body region, wherein the metal oxide layer is amorphous and has a smooth surface ...*", as recited in independent claims 22 and 30, as amended herein, and from which claims 29 and 37 depend respectively. The reasons are similar to those given above and previously.

The dependent claims are held to be patentable at least as depending from patentable base claims as shown above, since any claim depending from a nonobvious independent claim is also nonobvious. See M.P.E.P. § 2143.03. In view of the failure of the suggested combination of references to describe or suggest either thermal evaporation of pure metal, oxidation of the metal to form an amorphous oxide, or direct contact between the oxide and the semiconductor substrate, Applicant requests this rejection under 35 U.S.C. § 103(a) be withdrawn.

Reservation of Rights

In the interest of clarity and brevity, Applicant may not have addressed every assertion made in the Office Action. Applicant's silence regarding any such assertion does not constitute any admission or acquiescence. Applicant reserves all rights not exercised in connection with this response, such as the right to challenge or rebut any tacit or explicit characterization of any reference or of any of the present claims, the right to challenge or rebut any asserted factual or legal basis of any of the rejections, the right to swear behind any cited reference such as provided under 37 C.F.R. § 1.131 or otherwise, or the right to assert co-ownership of any cited reference. Applicant does not admit that any of the cited references or any other references of record are relevant to the present claims, or that they constitute prior art. To the extent that any rejection or assertion is based upon the Examiner's personal knowledge, rather than any objective evidence of record as manifested by a cited prior art reference, Applicant timely objects to such reliance on Official Notice, and reserves all rights to request that the Examiner provide a reference or

affidavit in support of such assertion, as required by MPEP § 2144.03. Applicant reserves all rights to pursue any cancelled claims in a subsequent patent application claiming the benefit of priority of the present patent application, and to request rejoinder of any withdrawn claim, as required by MPEP § 821.04.

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney David Suhl at (508) 865-8211, or the undersigned attorney (612) 349-9587 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

KIE Y. AHN ET AL.

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Date 9 July '07

By _____
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CERTIFICATE UNDER 37 CFR 1.8: The undersigned hereby certifies that this correspondence is being filed using the USPTO's electronic filing system EFS-Web,and is addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on this 9 day of July, 2007.

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Signature